Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2019-485-RC2, 2019

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Quantifying the impact of synoptic circulations on ozone variations in North China from April–October 2013–2017" *by* Jingda Liu et al.

Anonymous Referee #2

Received and published: 9 August 2019

General Comments: This paper provides a thorough analysis of the synoptic circulation patterns that influence ozone variability across North China. The methods are based on previous work and are clearly stated. The ozone data are from the extensive Chinese monitoring network and provide a clear view of ozone's distribution and variability across the study region. The paper concludes with an estimate of the impact of weather patterns on ozone changes from 2013 to 2017, which is an important and useful result. The paper could be acceptable for publication in ACP after the authors address my comments and concerns. My two main concerns deal with the need for improved referencing of previous work, and more details and motivation are needed regarding the ozone forecast equations. The standard of English is quite good, but there

Printer-friendly version

Discussion paper

are many instances of grammatical errors or awkward phrasing. The paper should be revised for English prior to publication.

Major Comments:

The title should be modified so that is uses the term “circulation pattern” rather than “circulations”. Circulation pattern is defined by the Glossary of the American Meteorological society, while circulations is not defined: http://glossary.ametsoc.org/wiki/Circulation_pattern Also, variability is a better word choice than variations. Therefore the title should be: “Quantifying the impact of synoptic circulation patterns on ozone variability in North China from April-October, 2013-2017” Throughout the paper “synoptic circulation pattern” should be the preferred term

The Introduction does a very poor job of referencing relevant papers in support of the claims made in the text: 1) Knowland et al 2017 is a nice paper on transport patterns, but it is not an appropriate reference regarding the impact of ozone on human health and vegetation. Likewise, Jacob and Winner focuses on how climate change will affect ozone. Instead see Fleming et al. [2018] and Mills et al. [2018]. 2) the papers by Liu et al [2007; 2012] focus on PM2.5 and are not authoritative papers for explaining ozone photochemistry. Instead see Monks et al [2009; 2015]. 3) Line 51: please provide a reference for APAPPC 4) Line 58: references are need for the impact of climate on ozone. Jacob and Winner is appropriate, as is Lu et al. [2019]. 5) Regarding the background on the association between transport patterns and air pollution, this paper is missing some key references (listed below), such as Moody et al. [1998] and Cooper et al. [2001]. Also, Section 4.4 of Monks et al. [2009] provides a very good summary of the early work (through 2008) on the relationship between synoptic patterns and air pollution transport. An important paper for China is Wang et al., 2009.

I have many questions regarding Section 3.4: 1) The authors need to explain why they developed the equations to forecast ozone. Is this just an academic exercise to see if its’s even possible? Has this method been requested by air quality managers? Is it

an alternative to atmospheric chemistry models that have not performed well? 2) How would this method work in operational mode? Would a weather forecast model be run to identify the synoptic circulation pattern for the next day, and then for a given city, select the equation that predicts ozone for that particular synoptic circulation pattern? Does Figure 9 show results for each city, using all five major synoptic circulation patterns? 3) The authors provided some summary statistics in the Supplement (Table S4) to describe the performance of the forecast equations, but these results are not very intuitive or easy to understand. It would really help if the authors can select a typical city and then report the predicted ozone values for the five major synoptic circulation patterns, and then report the range of values that were actually observed. For example, if the model predicts Beijing will have ozone of 160 ug m-3 tomorrow under Cyclonic conditions, but the observations show a range of 140 +/- 50 ug m-3 (where the uncertainty is 2 standard deviations) , the reader might conclude that the while the equation predicts a high ozone day there is a wide range of uncertainty. 4) Are the forecasts from these equations any better than the forecasts from an atmospheric chemistry model?

Minor Comments:

Line 63-65 This sentence is not well written. A better form would be: A given synoptic circulation pattern represents a particular range of meteorological conditions, therefore synoptic classification is a useful method for gaining insight into the impact of meteorology on ozone levels on the regional scale.

Line 182 Please explain how the exceedance ratio is calculated

Line 186 Beijing is a city, is it not? Or is “Beijing” referring to a large urban region that contains smaller cities?

Line 208 These references are not authoritative when describing the impacts of stratospheric ozone on China. A good overview is provided by Stohl et al., and a recent model analysis that quantifies the impact of the stratosphere on ozone above China is Verstraeten et al., 2015.

Line 209 It's not clear to me how the results of Tang et al. differ from your results. Please clearly state the results from Tang et al. and then show how your results are different.

Line 216 Not all of these references are authoritative. A good review of the relationship between ozone and temperature is Pusede et al., 2015.

Lines 256-259 These ozone fluctuations in relation to cold fronts have been reported for the eastern USA: Cooper et al., 2001 and Cooper et al., 2002

Figure 1. The blue boxes around some of the cities are very difficult to see. Please make the lines thicker.

Figure 4. The panels in this figure are far too small to be seen. This figure needs to fill an entire page, so that the reader can clearly see the information. Likewise, Figure S8 is impossible to read.

References:

Cooper, O. R., J. L. Moody, D. D. Parrish, M. Trainer, J. S. Holloway, T. B. Ryerson, G. Hübler, F. C. Fehsenfeld, S. J. Oltmans and M. J. Evans (2001), Trace gas signatures of the airstreams within North Atlantic cyclones - Case studies from the NARE'97 aircraft intensive, J. Geophys. Res., 106, 5437-5456, doi:10.1029/2000JD900574.

Cooper, O. R., J. L. Moody, D. D. Parrish, M. Trainer, J. S. Holloway, G. Hübler, F. C. Fehsenfeld, and A. Stohl (2002), Trace gas composition of midlatitude cyclones over the western North Atlantic Ocean: A seasonal comparison of O3 and CO, J. Geophys. Res., 107(D7), 4057, doi:10.1029/2001JD000902.

Fleming, Z. L., et al. (2018), Tropospheric Ozone Assessment Report: Present-day ozone distribution and trends relevant to human health, Elem Sci Anth, 6(1):12, DOI: https://doi.org/10.1525/elementa.273

Lu, X., et al., 2019. Surface and tropospheric ozone trends in the Southern Hemi-

sphere since 1990: possible linkages to poleward expansion of the Hadley Circulation. Science Bulletin, 64(6), pp.400-409.

Mills, G., et al. (2018), Tropospheric Ozone Assessment Report: Present-day tropospheric ozone distribution and trends relevant to vegetation, Elem. Sci. Anth., 6(1):47, DOI: https://doi.org/10.1525/elementa.302

Monks, P. S., et al. (2015), Tropospheric ozone and its precursors from the urban to the global scale from air quality to short-lived climate forcer, Atmos. Chem. Phys., 15, 8889-8973, doi:10.5194/acp-15-8889-2015

Monks, P. S., et al. (2009), Atmospheric Composition Change – Global and Regional Air Quality, Atmos. Environ., 43, 5268-5350.

Moody, J. L., J. W. Munger, A. H. Goldstein, D. J. Jacob, and S. C. Wofsy (1998), Harvard Forest regional-scale air mass composition by Patterns in Atmospheric Transport History (PATH), J. Geophys. Res., 103, 13,181–13,194.

Pusede SE, Steiner AL and Cohen RC (2015). Temperature and Recent Trends in the Chemistry of Continental Surface Ozone. Chemical Reviews 115(10): 3898-3918, doi:10.1021/cr5006815.

Verstraeten, W. W., Neu, J. L., Williams, J. E., Bowman, K. W., Worden, J. R., and Boersma, K. F.: Rapid increases in tropospheric ozone production and export from China, Nat. Geosci., 8, 690–695, https://doi.org/10.1038/ngeo2493, 2015.âĂĆ

Wang, T.,Wei, X.L., Ding, A.J., Poon, C.N., Lam, K.S., Li, Y.S., et al., 2009a. Increasing surface ozone concentrations in the background atmosphere of Southern China, 1994–2007. Atmos. Chem. Phys. 9, 6217–6227.

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2019-485, 2019.